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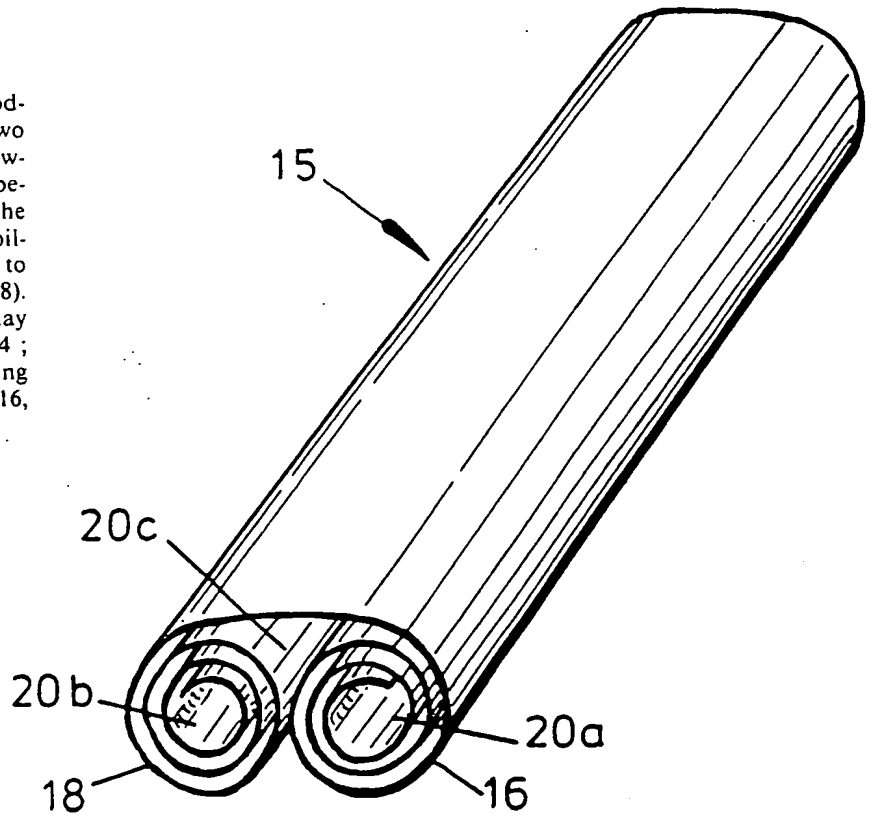
(57) Abstract

There is described a method of producing a yarn from a tape (10) including two layers of material (12, 14) of different drawability. The tape (10) is axially drawn beyond the elastic limit of at least one of the materials (14) which results in inward coiling from at least one edge of the tape (10) to form at least one longitudinal coil (16, 18). The layers of material (12, 14; 42, 44) may be arranged and two or more tapes (10; 24 ; 40) combined to provide yarns including various different combinations of coils (16, 18; 26, 28, 30; 46, 48).



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IMPROVEMENTS IN OR RELATING TO YARNS

FIELD OF THE INVENTION

This invention relates to improvements in or relating to yarns, including monofilament and multifilament yarns, and to improved methods of producing such yarns.

BACKGROUND OF THE INVENTION

Most textile or industrial yarns are produced from fibrous or filamentary materials which are spun, twisted, interlaced or bonded to make the fibres cohere. Such spun yarns require a large degree of manipulation to produce a finished yarn and the various spinning and twisting steps can result in mechanical damage to the fibres. Also, such yarns are prone to unravel in certain circumstances and such unraveling in, for example, a sewing thread may result in the yarn jamming in the sewing machine.

Some yarns consist of only a single relatively large diameter filament and are known as monofilament yarns. While relatively inexpensive to produce, such monofilament yarns have a number of disadvantages including low compressibility, which reduces the knottability of the yarns and which can lead to difficulties when, for example, monofilament yarns are used in forming sutures; the smooth surface of the yarns facilitates the formation of knots, though there is a tendency for such knots, once formed, to unravel. Monofilament yarns are also difficult

to coat, or more particularly do not retain coatings well, and this can lead to difficulty where the yarn is used, for example, as a lubricated sewing yarn and for this application monofilament yarn often must be supplied in a dispenser which coats the yarn with lubricant as it leaves the dispenser directly prior to use.

It is also known to make yarns from polymer film in which molecular orientation has been induced by stretching to such a degree that the film is capable of being converted into yarn or twine by manipulation, for example by twisting under tension, which results in the formation of a longitudinally split structure. This process is known as fibrillation and is relatively inexpensive, however the resulting yarns are harsh and the process may only be applied to a very restricted selection of polymers.

It is among the objects of the present invention to provide a yarn, and a method of producing yarn, which obviates or mitigates these advantages.

SUMMARY OF THE INVENTION

According to one aspect of the present invention there is provided a method of producing a yarn comprising:

(a) providing a first tape including two layers of material of different drawability; and then

(b) axially drawing the tape beyond the elastic limit of at least one of the materials to cause inward longitudinal coiling from at least one edge of the tape to form a yarn defining at least one longitudinal coil.

A single length of tape may be drawn to form a monofilament yarn, or a plurality of tapes may be drawn simultaneously and then spun or twisted together, possibly with other forms of yarn, to form a multifilament yarn.

As the drawability of the two layers of material are different one layer will draw more than the other and consequently reduces in width to a greater extent than the other layer. This width difference is accommodated by the tape curling inwards from at least one edge, away from the layer of lower drawability that is of greater width after drawing. The degree of coiling may be varied depending on the width and thickness of the tape and on the difference in draw ratios between the two materials.

The resulting yarn has molecular orientation enhanced in the longitudinal direction such that the tape tenacity and modulus are increased and the molecular orientation may be controlled to some degree to suit the end-use of the yarn. The coiled tape typically has a rounded cross-section and is laterally compressible, both of which features enhance knottability, knot-strength, resilience and reduce brittleness.

In the preferred method, the two layers extend substantially over the width of the tape such that on drawing the tapes coil inwardly from both edges to form two longitudinal coils. The two layers may extend substantially continuously over the length of the tape or one layer may be provided at spaced intervals. The

spacing between the areas where both layers are present may be small enough such that the drawn tape will still coil continuously over its length. Alternatively, the spacing may be greater such that areas of the drawn tape do not coil. Such a yarn may be employed for use in forming artificial grass: the stiffer, coiled portion of the yarn forming the grass "stalk", while the more flexible uncoiled portion forms the "leaf".

The two layers may be arranged to extend over opposite sides of the tape such that on drawing the tape forms two longitudinal coils of opposite sense. Thus, if the tape is drawn sufficiently, and the difference in drawability of the layers is sufficient, the two adjacent coils will each define a central chamber with a substantially closed longitudinal chamber therebetween, which chambers may accommodate a further material such as a lubricant, a fire-retardant, or any other material which it is desired to incorporated in the yarn. The further material may be located within the chambers by drawing the tape while it is immersed in a medium containing the further material and such a process is of particular advantage where the yarn is to form part of a composite material, such as a yarn reinforced tyre wall or a yarn and resin composite, and provides for secure anchorage of the yarn in the surrounding material. When the coils are formed tightly enough, the further material may be drawn into the coils by suction from one end of the yarn.

Alternatively, a liquid material may be drawn up the coils by capillary affect. A further method of incorporating a material in the yarn is to first draw the tape and maintain the tape in a substantially planar condition, then apply the further material to a surface of the tape before permitting the tape to contract axially to allow the edges of the tape to curl inwardly to form the coils and entrap the further material in the coils.

Conveniently, the tape is formed of two layers of polymeric material of different drawability. Such materials may include one or more polymers selected from acrylic, cellulose triacetate, cellulose acetate, cuprammonium rayon, modified acrylic, polyamides, polybutadiene, polyester, polyethylene, polypropylene, polystryrene, polyurea, polyurethane, polyvinyl alcohol, polyvinyl acetate, polyvinyl chloride, polyvinylidene dichloride, PTFE, viscose rayon or any natural, artificial or synthetic polymeric film-forming material or mixtures or co-polymers of these.

The material of one or both of the layers, or the further material incorporated in the yarn, may be selected to have properties which may change the yarn configuration after forming and such properties may be advantageously employed after the such yarns has been knitted, woven or otherwise combined. One of the layers of the tape may be formed of soluble material, such that when the yarn is exposed to an appropriate solvent said one layer will

dissolve and the yarn will tend to uncoil. Alternatively, one of the materials or the further material may be expandable on exposure to heat or a particular fluid.

Two or more tapes may be drawn simultaneously to provide tapes of different configuration. A further similar tape may be provided and located in overlapping relation with the first tape with the layers of material in a similar orientation such that on drawing both tapes are coiled together. Alternatively, the tapes may be positioned in overlapping relation and laterally mutually displaced with the layers of material in an opposite orientation such that on drawing the overlapped edges of the tapes combine to form a central coil. Further, a still further tape may be provided in overlapping relation with the tape with the still further tape adjacent the layer of material of lower drawability, such that on axial drawing the still further tape is coiled by the coiling of the first tape.

The configuration of the layers of material may be varied to provide different yarn configurations. Where one of the layers only extends over part of the width of the tape from one edge thereof, on drawing the tape will only coil inwardly from the one edge. Alternatively, if one of the layers of material is in two parts and one part extends over one half of the width of one side of the other layer and the other part extends over the other half of the width of the other side of the other layer, on

drawing the edges of tape will coil to collectively define a yarn of S-shaped cross-section.

The different drawability of the material of the layers may be provided by forming the layers of different material or by forming the layers of the same material and then treating one layer to change its extensibility by, for example, chemical, mechanical, radiation or heat treatment to produce crystallisation, differential drawing, cross-linking, swelling, grafting or any other molecular change that changes the extensibility of the material.

It is also possible to provide layers of different drawability by forming the tape of two separately extruded tapes of different thickness which are brought together immediately after drawing, and coalesce to produce a single homogeneous tape: the drawability of the thinner of the two tapes will be less than the thicker tape.

A tape may include a precursor carbon fibre polymer, and after the tape has been drawn to form the yarn the yarn may be carbonised to form a carbon fibre yarn. The carbonisation may occur after the yarn has been combined with other yarns. This process avoids the difficulties in manipulating relatively brittle carbon fibres to define a desired form, as the manipulation takes place, with the relatively flexible yarn, before carbonisation.

In accordance with a further aspect of the present invention there is provided a method of forming a warp

comprising:

providing a sheet comprising two layers of material of different drawability;

cutting the sheet to form a plurality of tapes; and then

simultaneously drawing the tapes beyond the elastic limit of at least one of the materials to produce a longitudinal coil in each tape.

This method provides a warp without the need for beaming, that is the gathering together and routing of a large number of separate yarns as is required in existing warp forming methods.

In accordance with a still further aspect of the present invention there is provided a yarn in the form of a length of tape defining at least two longitudinal coils.

Such yarns have lateral compressibility to provide enhanced resilience, toughness and knottability.

The yarn offers the further advantages that the coils may contain a further material or may define passages through which a further material may be drawn. The tape may be porous to allow movement of certain materials through the tape and such a yarn may be used in desalination or filtration processes.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other aspects of the present invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a somewhat schematic sectional end view of a first tape for use in a method in accordance with one embodiment of the present invention;

Figure 2 is an end view of a yarn, shown somewhat enlarged, produced from the tape of Figure 1 by a method of one embodiment of the present invention;

Figure 3 is a perspective view of the yarn of Figure 2;

Figures 4, 5 and 6 illustrate further tapes for use in methods in accordance with further embodiments of the present invention;

Figure 7 illustrates a yarn produced from the tape of Figure 6 by a method of a further embodiment of the present invention;

Figure 8 illustrates a still further tape for use in a still further embodiment of the present invention; and

Figure 9 illustrates the yarn produced from the tape of Figure 8 by a method of a still further embodiment of the present invention.

DETAILED DESCRIPTION OF DRAWINGS

Reference is first made to Figure 1 of the drawings which illustrates, somewhat schematically, a sectional end view of a first tape 10 for use in a method in accordance with one embodiment of the present invention. The tape 10 comprises two layers of material of different drawability, the lower layer 12 having the lower drawability. Thus, when the tape is drawn beyond the elastic limit of at

least the layer 14 of higher drawability, the width of the layer 12 will be reduced by a lesser extent than the layer 14 such that the edges of the tape will tend to coil inwardly to form a yarn 15 defining two longitudinal coils 16, 18, as shown in Figure 2 of the drawings.

The coiling may occur at the edges of the tape on drawing when a longer length tape 10 is drawn. However, if only short length of tape 10 is drawn and at least one end of the tape is held in the planar configuration, as shown in Figure 1, coiling will only take place after the tension in the tape is released or reduced; while the drawn tape is held planar, the differences in width of the layers 12, 14 are accommodated by elastic deformation of at least the layer of lower drawability 12, and when the tape is released the width of the layer 12 returns to its undeformed dimension, greater than the width of layer 14.

The layer 14 is formed initially by slitting an extruded polymeric film which, because it has not been fully drawn during manufacture, still possesses the ability to be drawn further. Before slitting the film is coated on one side with the layer 12 of lower drawability. Alternatively, the tape 10 may be extruded and used without slitting.

The arrangement of the layers 12, 14, extending over opposite sides of the tape 10, is such that on drawing the tape forms coils 16, 18 of opposite sense each defining a central chamber 20a, 20b. If the layers 12, 14 are

selected to have a significant difference in drawability, the coils 16, 18 meet in the centre of the yarn to define a further substantially closed longitudinal chamber 20c. A wide range of materials may be located within the coils 16, 18 and the three chambers 20a, 20b, 20c, appropriate to the end use of the yarn 15: for example, if the yarn is to be used in sewing, a sewing lubricant may be located in the chambers 20a - 20c. This may be achieved by drawing the tape 10 while immersed in lubricant, applying lubricant to the layer 14 before drawing, or injecting the lubricant into the chamber 20c between the coils 16, 18 in the formed yarn 15. In normal circumstances the lubricant is retained within the chambers but when the yarn 15 is transversely compressed, during the sewing operation, lubricant is squeezed from the chambers. Thus, the lubricant is only released when required in the sewing operation.

Reference is now made to Figure 4 of the drawings which illustrates two tapes 10 located in overlapping relation with the layers of material 12, 14 in a similar orientation. On simultaneous drawing, both tapes 10 will be coiled together to form a coiled yarn in which each coil includes a double thickness of tape 10.

Figure 5 of the drawings illustrates a tape 10 together with a further tape 24 which consists of a single layer of material 14. If the two tapes 10, 24 are drawn together the coiling action of the tape 10 will also tend

to coil the other tape 24 to form a thicker yarn.

Figure 6 of the drawings illustrates an arrangement where two similar tapes 10 have been positioned in overlapping relation though laterally mutually displaced and with the layers of material 12, 14 in an opposite orientation. When the tapes 10 are drawn together the three edges of the tapes 10 coil inwardly to define coils 26, 28 while the two overlapping edges coil together to form a central, double thickness coil 30 and thus form a single yarn 25.

Figure 8 of the drawings illustrates a different tape configuration 40 in which the material of lower drawability is applied as two separate layers 42a, 42b over the base layer 44, one layer 42a extending over one half of the width of one side of the layer 44 and the other layer 42b extending over the other half of the width of the other side of the layer 44. On drawing the edges of the tape coil in the same direction, in this case to define counter-clockwise coils 46, 48 to collectively define yarn 50 of S-shaped cross-section.

It will be clear from the above that the yarns in accordance with the various embodiments of the present invention may be advantageously used in a wide variety of applications. Such yarns may be used in reinforcing tyres and conveyor belts and the nature of the yarn provides for more secure anchorage in the, for example, surrounding rubber and thus reduces the possibility of delamination.

As mentioned above, yarns in accordance with embodiments of the present invention are particularly suited for use as sewing thread. In addition to the advantages mentioned above, such yarns are also translucent, which minimises the number of colours of thread which have to be provided to match the sewing thread with the materials to be sewn. This property may be enhanced by coating the tape, prior to its formation into a yarn, with material having a high refractive index.

The ability of the yarn to retain and contain material has application in many different areas. The yarn may contain a flame retardant material for use in forming flame retardant fabrics. Also, a yarn filled with iron or iron oxide particles may be used to produce an electro-magnetic screening fabric. Further, by providing barium sulphate within the yarn it is possible to produce a radio-opaque yarn for use in, for example, surgical swabs, such that the swabs may be located by x-rays if inadvertantly left in a patient's body. Also, a yarn formed of material with a poor affinity for dye may be filled with a dyeable material.

Yarns of the present invention may also be advantageously used in forming awnings, tarpaulins and tents, in that the hollow yarns may carry waterproofing material and also may contain fungicides and the like to prevent mould formation.

Similarly, yarns carrying waterproofing material may

be used in formation of waterproof fabrics for other applications, such as clothing. For use in clothing and the like, yarn may also be provided which contains a material that expands on exposure to moisture. This permits the formation of, for example, articles of clothing which will normally be permeable and thus be comfortable to wear but, when exposed to moisture, the yarns will expand to close the spaces between the yarns and thus produce an impermeable waterproof fabric.

The yarns may also be used to advantage in composite materials such as fibre reinforced plastics, where the resin material will tend to extend into the spaces between the coils of the yarn and thus firmly anchor the yarns in the surrounding resin.

Yarns in accordance with aspects of the present invention are also ideally suited for use as sutures, in that the smooth outer surface of the yarn facilitates the formation of knots in the appropriate locations while the transverse compressibility of the yarns decreases the possibility of the knots unravelling.

Yarns in accordance with aspects of the present invention may also be utilised in artificial turf where a coiled yarn may be used to provide a relatively stiff grass stalk, and where an uncoiled portion of yarn will provide a relatively flexible leaf.

Yarns may be also be used in the formation of seals or joins utilising two-part adhesive products. If a yarn

carrying an adhesive resin is, for example, wound around two objects to be joined and then a further yarn carrying a hardener is wound over the first yarn, on compression of the two yarns the resin and hardener will be squeezed from the yarns and brought into contact, and form a yarn reinforced adhesive joint.

The provision of a coil or chambers in yarns made in accordance with the present invention may be used to produce high wick fabrics. Such fabrics may be used in the production of bedding for incontinents or in forming the nibs of fibre-tip pens.

As yarns of the present invention are formed from a length of tape it is relatively easy to provide tapering tapes which may then be used to produce tapering yarns for use, for example, in the formation of high quality fishing lines. Such a process is clearly less complex than present methods in which such tapered lines are produced by reducing the number of yarns over the length of the line, for example, from 36 yarns to 18 yarns. Fishing lines formed from yarns in accordance with aspects of the present invention also offer the advantages of knottability and the absence of twisting or braiding which assists in preventing snarl.

The knottability of yarns in accordance with aspects of the present invention is also of use in the formation of fishing nets, in which material may be incorporated in the yarn to avoid biodegradation of the nets. Further,

the nature of the yarn also minimises damage to fish, in contrast to the equivalent monofilament yarn nets in which fish may be cut and damaged by the relatively harsh fibres of the net.

The possibility of forming a longitudinal chamber in the yarn may be used to advantage in a number of other applications, for example, to replace the hollow permeable fibres currently used in desalination plant. The present invention provides for the formation of semi-permeable hollow yarns through which salt water may be drawn, at relatively low cost.

Specific examples of embodiments of the present invention will now be described.

EXAMPLE 1

A 10μ thick sheet of polyethylene terephthalate film with 100% residual draw was coated on one side with 10% w/w of a commercially available polyurethane in emulsion form, and heated to dry and cure the polyurethane coating. The film was then slit into tape of 10mm width as depicted in Figure 1 and the tape was drawn between rollers set 30cm apart and with a draw ratio of 1.9:1. The edges of the tape curled sharply inwards and spiralled towards the centre of the tape producing a yarn with a C-shaped double spiral cross-section and resultant grist of 71.5 Tex. The cross-sectional shape was substantially as illustrated in Figure 2 of the drawings.

EXAMPLE 2

A sheet of polyethylene terephthalate sheet film with 62% residual draw and thickness 8μ was coated on one side with a commercially available polyurethane emulsion to provide a 42.5% add-on of polyurethane and passed through a heated zone to dry and cure the coating. The resultant film, now 11.4μ thick, was slit to form tapes of width of 3,860μ and these were drawn with a draw ratio of 60%. The edges of each tape rolled vigorously inwards on drawing forming a pair of coils each having approximately six single coils to produce a compact yarn. The physical properties of this yarn were:

Strength:	15.8N
Size :	368 dtex
Tenacity:	42.9cN/tex
Elongation at break	19%

This yarn was then lubricated with a commercially available sewing thread lubricant and sewn at 5000 stitches per minute on a Pfaff 483 (trade mark) lockstitch machine for 100 metres both forward and backward without breaks. A comparable sample of Tex 27 staple spun polyester thread tested similarly exhibited two breaks in the forward direction and nine breaks in the backward direction, and a sample of Tex 40 corespun thread performed with no breaks.

EXAMPLE 3

A combination of two polymers, polyethylene

terephthalate and a mixture of polyethylene terephthalate with 10% of poly-1:4-cyclohexanedimethanol terephthalate, were co-extruded to form a cast block which was drawn transversely with a draw ratio of 2.0 and longitudinally with a draw ratio of 3.8 to form a clear film of thickness 10μ, with a residual draw ratio of 40%. The film was then slit to make tapes of 10,000μ width which were drawn with a draw ratio of 38%. The resultant tightly rolled yarn had approximately 10 single coils in each coil formed. The resultant properties were:

Strength:	58.61N
Size :	990 dtex
Tenacity:	59.2cN/Tex
Elongation at break	19%

From the above described embodiments and examples it will be clear that the method of the present invention provides a simple process for the formation of yarns having desirable properties. It will of course be clear to those of skill in the art that the above described embodiments and examples are merely exemplary of the present invention, and that various modifications and changes may be made to these embodiments and examples without departing from the scope of the invention.

CLAIMS:

1. A method of producing a yarn comprising:

(a) providing a first tape including two layers of material of different drawability; and then

(b) axially drawing the tape beyond the elastic limit of at least one of the materials to cause inward longitudinal coiling from at least one edge of the tape to form a yarn defining at least one longitudinal coil.

2. The method of claim 1 in which the tape is drawn to form a coil defining a central chamber.

3. The method of claim 1 or claim 2, in which the two layers extend substantially over the width of the tape and on drawing the tape coils inwardly from both edges to form two longitudinal coils.

4. The method of claim 1, 2 or 3, in which the two layers extend substantially over the length of the tape.

5. The method of any one of claims 1, 2, 3 or 4, in which the two layers extend over opposite sides of the tape and on drawing the tape forms two longitudinal coils of opposite sense.

6. The method of claim 5, in which the tape is drawn sufficiently to define two adjacent coils defining a substantially closed longitudinal chamber therebetween.

7. The method of any one of the preceding claims, including locating a further material within said yarn.

8. The method of claim 7, in which the tape is drawn while immersed in a medium containing said further material.

9. The method of claim 7, in which said further material is drawn into the yarn from one end thereof.

10. The method of claim 7, in which the tape is first drawn and maintained in a substantially planar condition, said further material is then applied to a surface of the tape and the tape is then permitted to contract axially to permit the edges of the tape to curl inwardly to form the coil and entrap said further material.

11. The method of any one of the preceding claims, in which the tape is formed of two layers of polymeric material of different drawability.

12. The method of any one of the preceding claims in which the tape is formed by extrusion.

13. The method of any one of the preceding claims including the step of forming one of the layers of the tape of soluble material.

14. The method of claim 3 including the further step of splitting longitudinally the drawn tape to provide two coiled lengths of tape.

15. The method of any one of the preceding claims including the additional steps of: providing a further similar tape; locating the tapes in overlapping relation and with the layers of material in a similar orientation; and axially drawing both tapes together.

16. The method of any one of claims 1 to 14 including the additional steps of: providing a further similar tape; locating the tapes in overlapping relation and laterally mutually displaced with the layers of material in opposite orientation; and axially drawing the tapes together such that the overlapping edges of the tapes combine to form a coil.

17. The method of any one of claims 1 to 14 including the additional steps of providing a still further tape; locating the tapes in overlapping relation with said still further tape adjacent the layer of material of lower drawability; and axially drawing both tapes together such

that said still further tape is coiled by the coiling of the first tape.

18. The method of claim 1 or claim 2, in which one of the layers only extends over part of the width of the tape from one edge thereof and on drawing the tape only coils inwardly from said one edge.

19. The method of claim 1 or claim 2 in which one of the layers of material is in two parts and one part extends over one half of the width of one side of the other layer and the other part extends over the other half of the width of the other side of the other layer and on drawing the edges of the tape coil to collectively define an S-shaped cross-section.

20. The method of claim 1 or claim 2 in which the two layers are of a similar material, one of the layers having been treated to modify the drawability thereof.

21. The method of any one of the preceding claims including the further step of combining a plurality of drawn tapes by one of weaving, knitting, spinning and the like.

22. The method of claim 1 in which the tape includes a precursor carbon fibre polymer and after drawing the yarn

is carbonised to provide a carbon fibre yarn.

23. The method of claim 1 in which the tape is formed of one or more of acrylic, cellulose triacetate, cellulose acetate, cuprammonium rayon, modified acrylic, polyamides, polybutadiene, polyester, polyethylene, polypropylene, polystryrene, polyurea, polyurethane, polyvinyl alcohol, polyvinyl acetate, polyvinyl chloride, polyvinylidene dichloride, PTFE, viscose rayon or any natural, artificial or synthetic polymeric film-forming material or mixtures or co-polymers of these.

24. A method of forming a warp comprising:

providing a sheet comprising two layers of material of different drawability;

cutting the sheet to form a plurality of tapes; and then

simultaneously drawing the tapes beyond the elastic limit of at least one of the materials to produce a longitudinal coil in each tape.

25. A method of forming a multifilament yarn comprising:

extruding a plurality of tapes each comprising two layers of material of different drawability;

simultaneously drawing the tapes beyond the elastic limit of at least one of the materials to produce a longitudinal coil in each tape and thus form a plurality

of monofilament yarns; and then

combining the monofilament yarns to produce a multifilament yarn.

26. A yarn in the form of a length of tape defining at least two longitudinal coils.

27. The yarn of claim 26, in which the coils are of opposite sense.

28. The yarn of claim 26 or claim 27, in which each coil defines a central chamber.

29. The yarn of claim 26, 27 or 28, in which the coils are substantially adjacent one another and define a substantially enclosed longitudinal chamber therebetween.

30. The yarn of claim 26, 27, 28 or 29 in which a further material is contained within the coils.

31. The yarn of any one of claims 26 to 30, in which the film is porous.

32. A yarn in the form of a length of tape defining at least one coil and said coil defining a central chamber.

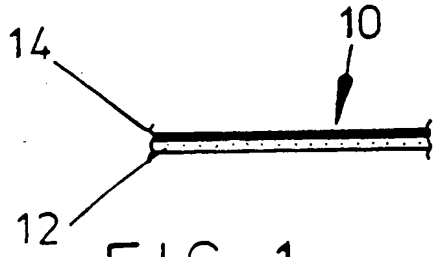

FIG. 1

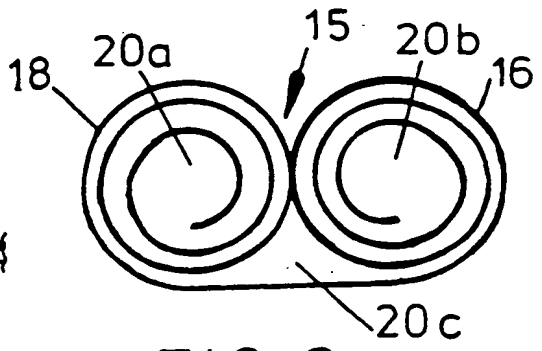

FIG. 2

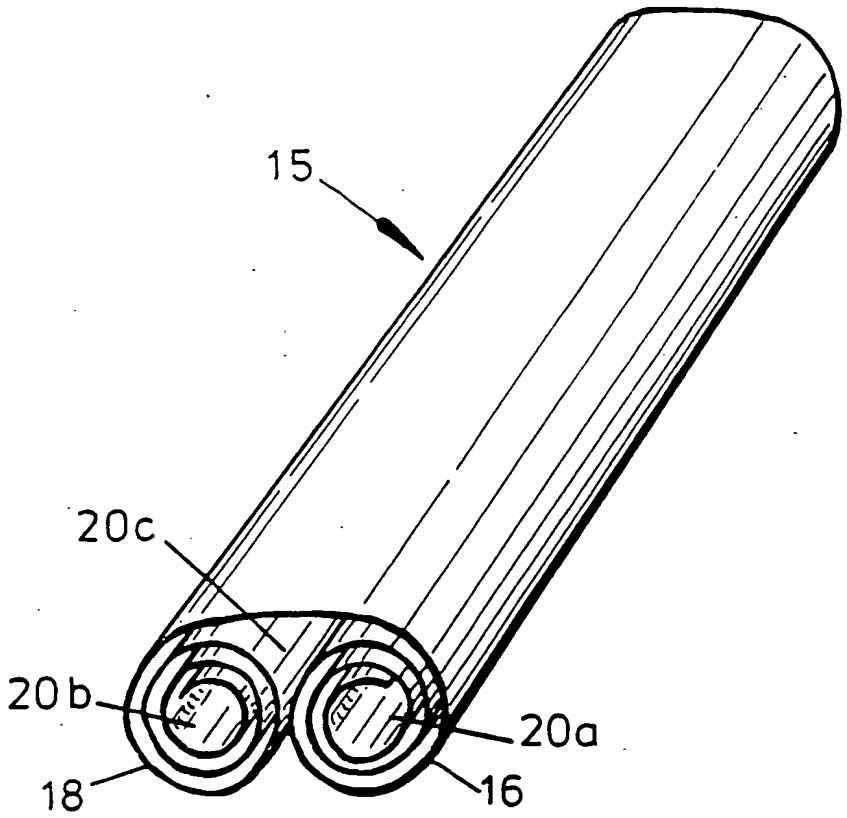

FIG. 3

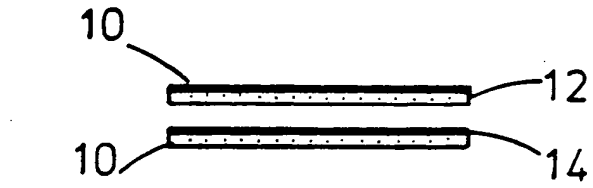

FIG. 4

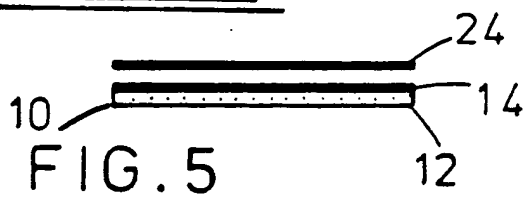

FIG. 5

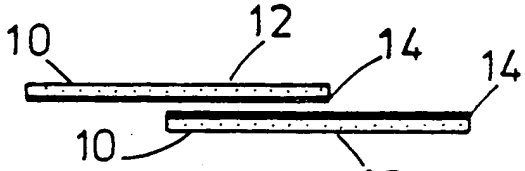

FIG. 6

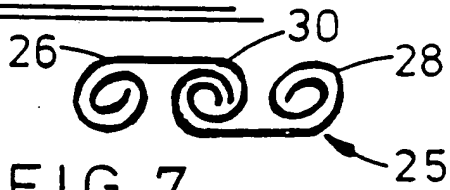

FIG. 7

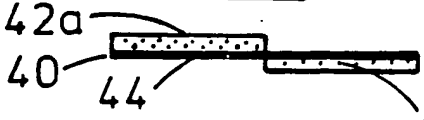

FIG. 8

FIG. 9

INTERNATIONAL SEARCH REPORT

PCT/GB 92/02300

International Application No

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all)[6]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl. 5 B32B7/02

II. FIELDS SEARCHED

Minimum Documentation Searched[7]

Classification System	Classification Symbols
Int.Cl. 5	B32B ; D02G ; D07B ; D02J

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched[8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT[9]

Category °	Citation of Document,[11] with indication, where appropriate, of the relevant passages[12]	Relevant to Claim No.[13]
X	US,A,3 416 991 (TOYOBO LTD.) 17 December 1968	1-4,7, 9-13,20, 23,25, 26, 28-30,32
A	* whole document *	14,21, 24,31
X	GB,A,1 091 588 (TOYOBO CO. LTD.) 22 September 1965	1-4, 10-12, 14-17, 20,23, 26, 28-30,32
	see page 1, line 38 - page 4, line 122	

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"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
12 FEBRUARY 1993	04. 03. 93
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	VAN BEURDEN-HOPKINS

Form PCT/ISA/210 (second sheet) (January 1985)

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO.

GB 9202300
SA 67527

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report.
The members are as contained in the European Patent Office EDP file on
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-3416991		None	
GB-A-1091588		None	

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For more details about this annex : see Official Journal of the European Patent Office, No. 12/82